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THE DEVELOPMENT AND EVALUATION OF PROGRAMED INSTRUCTION IN LANGUAGE FOR CHILDREN WITH AUDITORY DISORDERS.

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THE FEASIBILITY OF PROGRAMING WRITTEN LANGUAGE FOR THE INSTRUCTION OF DEAF CHILDREN WAS STUDIED. A PROGRAM WAS DEVELOPED AND PRESENTED TO A GROUP OF DEAF CHILDREN. A CONTROL GROUP WAS TAUGHT THE SAME LESSON CONTENT BY TEACHERS. DATA WERE PROCESSED BY A COMPUTER. THE TOTAL SCORE RELIABILITY OF THE LANGUAGE TESTS WAS DETERMINED BY THE APPLICATION OF RIELON'S FORMULA (1939) TO THE COMPOSITE SCORES. THE EXPERIMENTAL AND CONTROL GROUPS WERE TESTED FOR HOMOGENEITY OF VARIANCE ON COMPOSITE SCORES AND ON EACH OF SIX LANGUAGE VARIABLES, AN F-RATIO BEING COMPUTED ON EACH. THE HYPOTHESIS OF A COMMON POPULATION MEAN WAS EXAMINED BY MEANS OF A T-TEST. ADDITIONAL STATISTICAL PROCEDURES WERE USED IN (1) DAILY RECORD SHEETS, (2) TESTS OF RETENTION, AND (3) ORIGINAL STUDENT RESPONSES. OBSERVATION MADE BY THE TEACHERS PROVIDED ANECDOTAL INFORMATION. WHILE THE INTERNAL CONSISTENCY OF TEACHER INSTRUCTION WAS HIGHER THAN THAT OF PROGRAMED INSTRUCTION, NO SIGNIFICANT DIFFERENCE WAS FOUND BETWEEN THE MEAN SCORES ON FIVE OF SIX LANGUAGE VARIABLES. THE CONTROL GROUP SCORED SIGNIFICANTLY HIGHER ON ONE VARIABLE. THE PROGRAMED INSTRUCTION REQUIRED LESS THAN ONE-HALF THE TIME ASSIGNED TO TEACHER INSTRUCTION. WRITTEN RESPONSES WERE CORRECT ON OVER 90 PERCENT OF THE FRAMES. LESS THAN 5 PERCENT OF THE TOTAL RESPONSES SHOWED UNCORRECTED ERRORS. PARTICIPATING TEACHERS REACTED WELL TO THIS METHOD OF WRITTEN LANGUAGE INSTRUCTION. (HB)

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The Development and Evaluation of Programmed Instruction in Language for Children with Auditory Disorders

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I. Introduction

Congenital and early adventitious deafness imposes a profound communication deficit. In 1960, 24,958 children with severe auditory impairments were enrolled in public schools with special provisions for their education (American Annals of the Deaf, 1961). Many extraordinary teaching techniques have been devised for educationally deaf children, all of which are directed toward the alleviation of the receptive and expressive language impairment.

During the course of this study, the investigators have noticed repeatedly the enthusiasm with which teachers of the deaf have greeted the development of programmed instruction. Indeed, interest would appear to be warranted for several reasons.

1. The typical class of deaf children numbers less than ten. Programmed instruction commends itself to desired individualized instruction by permitting the teacher to assume a tutorial role.

2. *Instruction to the deaf is directed primarily through the* visual modality, the same input modality through which programmed instruction generally is directed.

3. Due to many variables, including age at onset of deafness, severity of loss, differences in time, amount and quality of initial language instruction, and frequency of multiple handicap, most classes of deaf children are widely heterogeneous in language ability. The self - pacing characteristic of programmed instruction adapts it to such a range.

4. Formal written language instruction is frequently highly systematic and structured. Programmed instruction meets both criteria.

On the other hand, considerable experimentation is also warranted.

1. Programmed instruction is untested in establishing a language with children in whom little or no language is present. Can pictures substitute for the verbal stimulus?

2. Language requires syntax. Can full sentence responses be precisely controlled without the use of verbal stimuli?

3. Will language responses learned through programmed instruction transfer into functional expressive language?

4. Language is a vehicle for cognition and conceptualization. What is the effect of programmed language instruction on these processes? More specifically, can generalization and discrimination be established from pictures?

It is the purpose of this investigation to examine several of these points.

II. The Problem

This experiment explored the effect of programmed presentation of written language on learning among deaf children. The feasibility of a programmed instructional procedure was evaluated in terms of the following questions:

1. What are the relative effects of (a) programmed instruction and (b) conventional teacher instruction, on the acquisition of written language?[1]
2. Which presentation, if either, represents greater efficiency as measured by savings in time?
3. What is the relative effect upon retention of the two procedures of instruction?
4. Are the perceptual skills of young children sufficiently developed to permit them to match their full sentence responses with the correct answers?
5. How do teachers of the deaf react to programmed language instruction in their classrooms?

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[1] Criteria under IV, A., "Language selected for instruction."

III. Review of the Literature

Educators of the deaf are in agreement that deafness in young children is responsible for a severe language deficiency. The extent of this deficiency as well as its nature has not been fully explored, due in part to the inadequacy of test instruments.

A. Language evaluations

Fusfeld (1955) administered the Stanford Achievement Test to candidates for admission to Gallaudet College. The mean scores fell at the ninth grade level. Because of the selection factor, candidates probably tested much higher than the typical deaf population. In addition, the concurrent validity of the standardized achievement test as applied to the deaf is open to doubt. A recent study by Niiler (1961) supports this statement in the area of reading also.

Two investigations have analyzed the original written language of the deaf. By original language is meant discourse initiated by the child, ie., narrations, expositions, descriptions. Walter (1959) made such an analysis and observed an absence of complexity, loose structure and a restriction of alternative ways of expressing an assertion. A more detailed investigation of the language of the deaf was conducted by Myklebust (1960). He studied the written responses of 1,000 deaf chidren to a carefully selected picture. The sample ranged in age from 7 to 17. Myklebust scored responses on the basis of syntax, sentence length, and level of abstract thought. The deaf were significantly inferior to a hearing sample by all three criteria. On sentence length, Myklebust writes, "at eleven years the mean (sentence length) for the deaf was 4.98, and for the hearing it was 12.09. This emphasizes the

fact that early life deafness restricts language acquisition and usage " (1960, p. 383).

Heider and Heider (1940) analyzed the expressive language of a group of deaf children, concluding that the differences between the deaf and hearing reflect differences in the "whole thought structure." In contrast, DiCarlo (1959) reports that where significant differences are found in the cogitive processes, they appear to be of degree rather than of kind.

B. Methods of teaching language

Two general approaches have been devloped to meet this language deficit. The first is typified by a procedure outlined by Groht (1958). Her method is based on the premise that language should be established directly from meaningful experiences which have stimulus value for the elicitation of the language.

A second general approach is typified by the work of Fitzgerald (1937). Highly structured, the Fitzgerald System is first an outline for the systematic establishment of parts of speech and syntax. A group of symbols called the Key have been developed to assist the child in the correct ordering of a sentence. This elaborate system covers all parts of speech, cueing the deaf child in correctly ordering any declarative sentence. The symbol ═══ represents the verb, ┌──┐ represents the predicate adjective, and ——— represents the predicate nominative. Noun vocabulary is taught under "Who" and "What".

Who: ═══ ——— could symbolize
What: ┌———┐

"A cardinal is red," or "A cardinal is a bird." The reader might well identify this system with structural grammar.

Because of their wide application in teaching the deaf, Fitzgerald Key headings were used in this investigation, as described later under

"Development of the program."

C. Programmed instruction

It was the intention of the investigators to explore the feasibility of programming written language for such a population as has been described. For the basic principles and background of programmed instruction, the reader is directed to Stolurow (1961) and Deterline (1962) and for specific research descriptions to Lumsdaine and Glaser (1960).

D. Stimulus material

To program written language for young deaf children is quite unlike programming a foreign language. The latter typically employs a paired-associates method. Reporting on instructional devices in foreign language teaching, Porter (1960) states, "Learning the receptive aspects of a foreign language involves, not the learning of new responses, but the attaching of old responses (native language responses) to new stimuli" (p. 190).

Such a procedure could not be followed by the investigators because no formal language had been established as a referent by the population under investigation. The stimulus material available to the investigators was solely that of the visual and other sensory nonsymbolic experiences of the deaf child.

Hartman (1961) has reviewed the research related to the comparative effectiveness of single sensory input channels as inducements to learning. The three media of print, audition and pictorial stimulation were considered. Hartman states that the weight of the studies favored the pictorial channel. However, Hartman cautions against a general conclusion due to the differences in the subject matter of the various investigations.

Asher (1961) investigated the learning of Spanish under three stimulus conditions: the printed English word, pictures, and the aural English word. This investigation was conducted with a population of adults. The relative stimulus value of the printed word and the picture could not be compared with one another, but results indicated both to be superior to the aural stimulus in initiating learning.

In his discussion, Asher states, "The evidence is quite definitive in showing that if one learns language materials first by vision, and then relearns by audition, there will be ... a significant acceleration in initial learning" (1961, p. 58). It might be suggested that this statement holds implications for the speech training of children with some usable auditory residual; that for such children written language instruction should precede speech instruction which utilizes audition. While Asher's investigation gives support to the use of pictures as stimulus material, the question arises whether language continued to play a mediating role between picture and foreign word.

The use of the picture as exclusive stimulus is not unique to this investigation, being a procedure used frequently by teachers of the deaf. Falconer (1960) employed pictorial stimuli to establish sight vocabulary among deaf children. No control group was employed in this study, but empirical inspection suggests that substantial gains were made by the group under instruction.

E. Response and feedback

A pilot study was conducted preliminary to this investigation. Like Falconer (1960), these investigators utilized a picture stimulus to evoke a single word response. The purpose of the study was to determine an appropriate programming procedure for teaching expressive noun vocabulary.

Keislar and McNeil (1962) report no significant difference between overt and covert response modes in their effect upon learning. The constructed response was required in this investigation since such a response was in fact the terminal behavior sought. Syllables were successively faded. Learning took place with a minimum of error. Porter (1959) had also employed this technique successfully in teaching spelling to second and sixth grade children.

Porter had also observed that numerous second grade children were unable to match their responses independently with the correct answers appearing in the program. Porter's observation seems relevant to this investigation. Would the incorrect feedback arising from such inadequacies interfere with learning increasingly with full sentence responses?

IV. Plan of the Study

A. Language selected for instruction

Several criteria were employed for the selection of the language to be considered in the investigation. First, it must be suitable for instruction to deaf children within a specific age range. Second, the language must be sufficiently diverse as to permit a general conclusion to be made about programming as applied to language. Third, the language must be consistent with current language courses of study. Fourth, it must approximate a typical month's instruction as taught conventionally by teachers of the deaf.

For the purpose of this investigation, syntax was described traditionally rather than structurally, traditional grammar permitting the language to be treated with discreteness as parts of speech. Traditional definitions aided also in communication with participating teachers.

Language outlines were collected from several outstanding schools for the deaf. The investigators, after consultation with a curriculum authority[1], selected four parts of speech and vocabulary for programming. It was recognized that some of the subjects already would have been taught some of the selected parts of speech, due to the wide variation in curriculum practices within the population from which the sample would be drawn. However, the effect of such differences would be minimized through the split-plot randomization technique. Accordingly, the following language variables were selected for investigation.

1. Nouns. It is obvious that language could not be taught outside a word medium. Rather than assume a written vocabulary known to all

---

[1] Miss Marian Quick, Academic Principal, Western Pa. School for the Deaf

children, it was decided to formally teach all the vocabulary to be employed and to consider vocabulary, like parts of speech, as a variable.

Selection of vocabulary could not be made by reference to either normative reading lists or spelling lists. While these have been standardized on hearing populations, none have been standardized on deaf groups. Language outlines prepared by educators of the deaf were again employed as a criterion for vocabulary selection, those words being selected as were considered to facilitate instruction in specific parts of speech.

The following twenty-seven nouns comprised the vocabulary list:

a peacock	a dog	the weather
a lion	a house	an elephant
an owl	a church	a rope
a deer	a store	a rocket
a girl	a barn	a thread
a boy	a school	a horse
a sailor	a doll	a baby
a doctor	a kite	___ milk
a fireman	a ball	___ ice

2. Verbs. Since verbs have such a dominant role in determining the intelligibility of a sentence, they were selected as a language variable. Deaf children experience extreme weakness in employing the verb correctly, both in selecting the most appropriate verb and using the correct tense. For that reason, too, it was considered important to attempt their teaching through programmed materials.

The following were selected as seven verbs which are taught early in the language training of deaf children. They include the regular and irregular, transitive and intransitive, the intransitive group including a copulative verb.

is (are)	was (were)	will be	
play(s)	played	will play	is (are) playing
walk(s)	walked	will walk	is (are) walking
run(s)	ran	will run	is (are) running
jump(s)	jumped	will jump	is (are) jumping
swim(s)	swam	will swim	is (are) swimming
throw(s)	threw	will throw	is (are) throwing

It was assumed that all subjects had been instructed in the use of the past, present, and future tenses. This assumption later proved unfounded when it was seen that schools differed widely in the instruction of these tenses. The present progressive tense was added as a tense thought to be unknown to the students (later substantiated). This tense would be certain to test original learning. The seven verbs were selected for instruction in the third person singular and plural only.

3. Predicate adjectives. Three adjectives were selected. Again, it was assumed that the subjects would have some familiarity with these words, but strictly as attributive adjectives. Learning the appropriate selection and placement of the predicate adjective following the copulative verb would indicate knowledge that the adjective is relative to its antecedent, for instance, "a horse is strong" and "rope is strong" although horse and rope are not closely associated.

The three predicate adjectives selected for instruction were:

cold
strong
big

4. Comparative adjectives. This variable was selected because it provided a measure of the subject's ability to perceive errors in a sentence of some length. Also, use of the comparative adjective requires comprehension of the correct ordering of the sentence, a skill critical to adequate language development. The comparative forms of the adjectives "cold, strong, and big," yielded the following:

colder than_____
stronger than_____
bigger than_____

5. Predicate nominatives. The predicate nominative provided an indication of language development as it reflects conceptualization. The predicate nominative is a generalization of which the subject denotes a sub-class. To have full understanding of "a dog is an animal", the child presumably must recognize "animal" as a class of which "dog" is a member. The predicate nominative, then, would contribute information on concept formation.

The following nouns were selected for instruction as predicate nominatives:

man
animal
building
toy

Two additional language variables, the adverbial phrase and the expletive, were tentatively selected and subsequently deleted because their inclusion would have required a substantial extension in the experimental period.

B. Development of the program

The language selected for instruction was programmed in twenty units. Each unit comprised a day's instruction.

An artist was employed to sketch black and white illustrations. Drawings accepted for the program were those which appeared to the investigators to (1) avoid distracting details and (2) have high stimulus value. Eighty-three illustrations were incorporated into the program, those illustrations being frequently repeated with different frames. Every frame therefore contained a picture stimulus.

Trial runs were conducted upon deaf children attending a particular school for the deaf which served for preliminary trials only. These trials were conducted at the University by the investigators, one subject at a time. With the first draft of the program it was noted that the children were unable to attend to the program alone, requiring considerable support from the adults present. The mean time required for completion of each daily program was 38 minutes. The error count of the program before revision was high, approximately 25 per cent of total responses.

The prepositional phrase and the expletive were dropped from the program, permitting a considerable addition of frames to support instruction in the remaining parts of speech. Such a procedure was necessary because the experimental period could not be extended beyond a certain duration due to exigencies in the participating schools.

Final revision of the program produced a total of 534 frames, the twenty units varying between 24 and 31 frames. The program was linear in design, and required constructed responses.

Program Unit	Number of frames	Instruction
1	30	"be" (past, present, future)
2	25	"be" (past, present, future)
3	30	"be" (past, present, future)
4	24	"be" and "play" (past, present, future)
5	26	"walk, jump"
6	30	"swim, throw, run"
7	29	review of verbs, introduction of present progressive
8	25	all verbs in present progressive
9	26	review of all verbs in all tenses
10	31	"man, animal" - in predicate nominative.

11	27	"building, man, animal" in predicate nominative
12	24	"toy" in predicate nominative and others reviewed
13	29	review of verbs and predicate nominative
14	25	"strong, big" as substantive and predicate adjectives
15	25	"cold" as predicate adjective and others reviewed
16	25	review of verbs, predicate adjectives and predicate nominatives
17	25	review of predicate adjectives, introduction of comparative adjectives
18	24	"bigger than, colder than"
19	25	total review
20	24	total review

The parts of speech were so ordered in their presentation as to provide support for that which would follow and review for that which had preceded. The predicate adjective, for instance, was taught during units fourteen and fifteen to provide a review on the copulative verb while introducing concepts to be strengthened in the instruction of the comparative adjective.

The underlying concept of time required in the appropriate use of the past, present, future and present progressive tenses could not be conveyed through single pictures. Artificial cues were employed to instruct the subject in the mechanics of writing each tense. These tenses were made meaningful to the subjects in a manner described later in the report.

Only that language which could be readily cued pictorially was selected for programming, ie., all subjects were in the third person.

singular or plural. All sentences were declarative, describing the content of the accompanying illustration.

Drills were employed in the instruction of verb tenses. There were 169 such frames. An additional 33 frames provided vocabulary instruction outside the context of a sentence. Of the total program content, 332 frames or 62% required full sentence responses.

These five Fitzgerald Key symbols were incorporated into the program because of their cue value and general employment in schools for the deaf.

Who: ——
What: ═ ⌐——

Verb tenses were cued by means of the verb symbol and below it, the name of the required tense, ie.

═

Present Progressive

The symbolic cues served two purposes. First, pictorial cues alone would permit a wide variety of full sentence responses. The symbolic cues would serve to direct subjects to produce responses specifically sought. Second, it would be necessary, in the post-instructional testing, to control the responses of subjects in order to evaluate the instruction.

The attention of the subject was directed first to the picture-stimulus; he then noted the symbolic cues as provided by Fitzgerald Key symbols. Beneath these symbols were horizontal lines indicating the number of words required in the response.

Words were initially presented to subjects with lines beneath them. This prompt was planned to create an initial association between the pictorial representation of the object and its symbol. These words

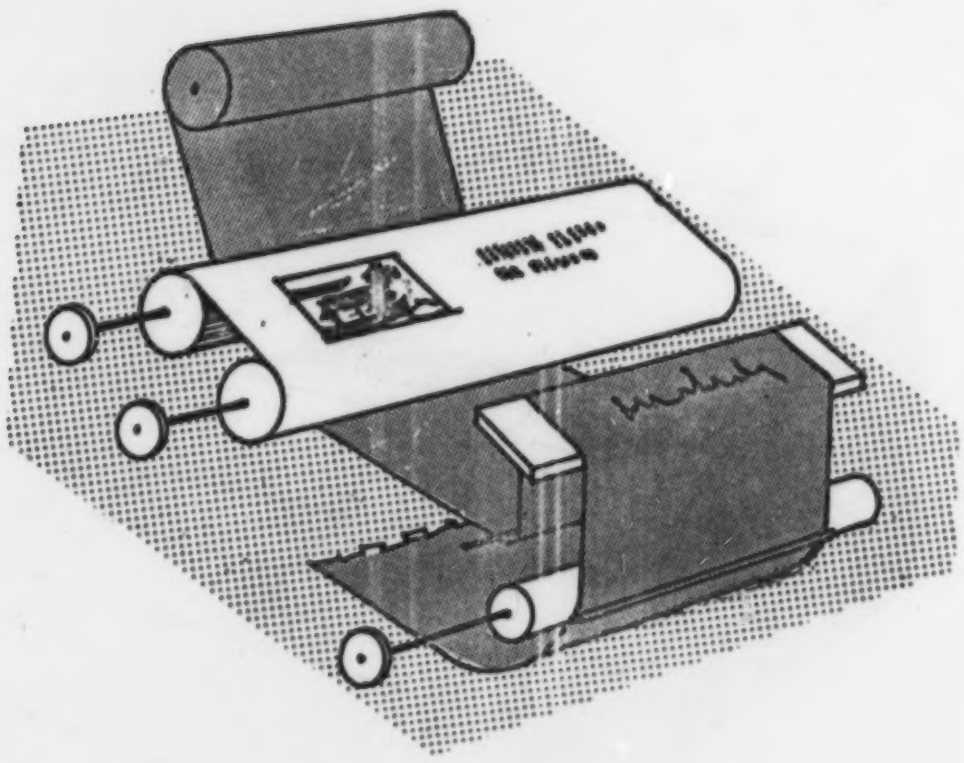
were subsequently divided into syllables, with one syllable being omitted on succeeding frames, dashes serving to indicate the number of letters required to complete the word until only dashes appeared, each indicating a letter. Dashes were then omitted, only the horizontal line remaining. Cues thereby faded, confirmation replacing prompting.

Illustrations and the Fitzgerald Key symbols remained before the subject, illustrations as unconditioned stimuli, Key symbols as conditoned stimuli. (Appendix E, sample frames 1-7).

Absence of the conditioned stimulus would have had one of two effects. First, control of the subject's responses to the unconditioned picture stimulus would have been reduced, with the consequent lack of response reinforcement. Second, a response would be conditioned to the picture-stimulus so that the subject might invariably write the same sentence in response to a given picture stimulus. This would be incompatible with instruction directed toward effective language. However, by keeping the picture constant and altering the Fitzgerald Key symbols, the investigators were able to alter the total stimulus. (Appendix E, sample frames 8 and 9).

The foregoing presents a description and the rationale of the program. It was earlier stated that the program was divided into twenty units, of 24 to 31 frames each.

Each unit was placed on a roll of paper six feet in length. This roll, together with a blank roll, was placed within a self-instructional device.

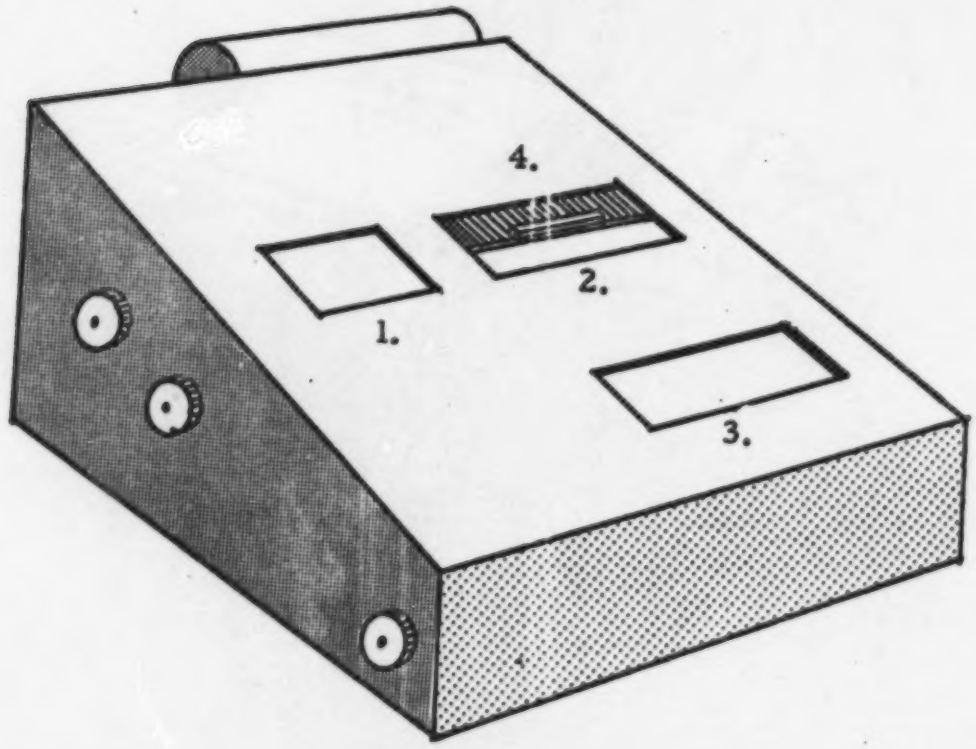


Self-instructional device (cover removed)

The device was built upon a plywood base. The program was fed unto two rollers, each with a knob. One knob advanced frames. The other knob permitted rewinding the roll without removal of the cover.

A blank roll of several hundred feet of paper was attached outside the cover. Paper ran off this roll over a writing platform. This roll was advanced by a third knob which diverted the paper through a slot under and behind this device, only that portion upon which the subject was writing being visible to him.

The sequence of operations involved in making a response is as follows:



Cover in place

1. The subject viewed an illustration through an open window.

2. He observed the Fitzgerald Key headings and any additonal cues in a second window.

3. He recorded his response on blank paper appearing through a third window.

4. He pulled a lever toward him to reveal the correct answer.

That same operation moved a transparent plastic shutter over his response, thereby discouraging any temptation to copy. Holding the lever, he matched his response with the correct answer. Release of the lever returned the shutter again over the correct answer, removing the trans-

parent shutter from his response. He then made any necessary correction in his response. If a correction was necessary he repeated this operation to check the accuracy of his correction.

In this way he proceeded through the entire unit.

C. Population

Of the total number of deaf children receiving special instruction in public school settings in 1960, 15,826 children were being educated in residential settings and 9,132 children were being educated in day settings (American Annals of the Deaf, 1961). In order to obtain a stratified sample from each of these two settings the investigators invited four residential and two day schools to consider participation in the experiment. These six schools were approached because of their large student bodies and convenient geographical locations. A third criterion was that the Fitzgerald System of Language Instruction be employed in each school. All the schools invited to participate offered their full cooperation.

Name of School	Day or Residential	Student Enrollment	Location
A.G. Bell School for the Deaf	Day	149	Cleveland, Ohio
Ohio School for the Deaf	Residential	234	Columbus, Ohio
Pennsylvania School for the Deaf	Residential	490	Philadelphia, Pa.
W. Pa. School for the Deaf	Residential	413	Pittsburgh, Pa.
West Virginia School for the Deaf	Residential	211	Romney, West Virginia

W. & E. Martin School
for the Deaf Day 194 Philadelphia, Pa.

Classes in each of these schools were observed by the investigators. The criteria established for the final selection of each participating class were as follows:

1. That the mean age in the class be approximately ten years.

2. That the predominating handicap in the class be deafness, special classes of mentally handicapped or aphasic children being excluded. However, it was recognized that mentally handicapped children would be present in the classes selected so that the results of the investigation would have bearing on these children also.

3. That the teacher of the class be competent in the use of the Fitzgerald System and willing to participate in the investigation without outside pressure.

No effort was made to judge general teaching competency. Competencies of the participating teachers were therefore considered to be randomly distributed.

On the basis of these criteria, thirteen classes of children were selected for the investigation, eight classes selected from the four residential schools, and five classes selected from the two day schools.

The children in each class were randomly assigned to experimental and control groups of approximately equal size, by the investigators, using a split-plot technique.

The total original population of the thirteen classes was 108 children. Ninty-nine were used in the investigation. One child was excluded prior to the experiment because of severe preceptual and emotional disorders. Eight children were absent at the time of testing. Since the criterion variables (test scores) were lacking for these subjects, they

were excluded from the analysis.

A total of 99 children remained, 52 subjects in the experimental group, 47 subjects in the control group. The numbers are unequal because some classes had an odd number of students, and because there were more absences at the time of testing among the subjects assigned to teacher-instruction. No subjects were excluded by reason of absence during the experimental period.

Information was collected after assignment to experimental and control groups. This information is reported in the following table:

Table 1: Description of Experimental and Control Groups[a]

	No. of subjects	Mean age	Mean I.Q.[b]	Sex
Experimental	52	10 yrs. 3 mos.	95.4 (n=41)	29 male 23 female
Control	47	10 yrs. 3 mos.	95.8 (n=39)	24 male 23 female
Total	99			

a. Due to the effects of randomization, no differences in any variable are expected other than those occuring by chance alone.

b. Psychological test results were unavailable on nineteen children. The six schools employed different non-verbal measuring instruments and mean I.Q.'s were calculated from these. These scores, the means of which are shown in Table 1., were collected only to support general levels of mental ability, not as the basis for matching groups.

D. Preparations for the experiment

The investigators met with the participating teachers and their

supervisors in each school. Each conference was held two weeks before the experiment was to begin in that school. The investigation was discussed fully, the operation of the devices explained, and instructions given. Care was taken that the teachers feel comfortable with the experiment and that its competitive aspects be minimized.

The subjects having received language instruction for several years, it was considered unnecessary to program very basic language concepts. Nevertheless, to guarantee a common basal language level, teachers were instructed to review several language principles and concepts. The two week period preceding the experimental period permitted equal instruction by teachers to both the experimental and control groups of each class in the following:

1. Instruction was to be given in underlying concepts and the terms, "past, present, future." Tenses were considered to be best taught within the context of personal experiences of the children, difficult to program. Teachers revealed that tenses had been taught without use of the above terms. Instead, "before, now, after awhile," etc. had been employed, possibly because these terms can be more easily speechread. The present progressive tense was to be taught during the experimental period.

2. Pluralization of common nouns by the addition of "s", and the compounding of nouns with the addition of the conjunction "and" were to be reviewed.

3. Children were to be instructed that "who" and "what", Fitzgerald Key symbols, denote male and female genders, and neuter gender, respectively.

Manuals were prepared for the participating teachers. These manuals reinforced and elaborated the instructions conveyed in confer-

ence. Manuals also created a consistency of instruction within the six schools. (See appendix A, Teacher's Manual).

E. The experiment

1. Schedule - The experimental phase of the investigation was staggered by schools over a six month period. The teacher within each participating class maintained a standard daily time-schedule for the experimental and control groups with the exception of the instruction under experimental control. Informal language instruction was to be presented as usual through news, calendar work, and the like. The language under investigation was to be avoided outside the controlled language period except as this avoidance would interfere with other instruction; i.e., the 27 word vocabulary list was not to be deliberately introduced outside the controlled language period unless it appeared in the class reading or a child wished to use it spontaneously in his language.

2. Experimental group - Subjects within the experimental group were not permitted to participate in the formal language as taught by the teacher. Screens were erected to isolate members of the experimental group from the control group during that period. As these subjects all had profound hearing losses, no additional sound controls were necessary.

It might be added that an almost perfect experimental situation was present. Both the experimental and the control presentation could be conducted simultaneously in the same classroom. The screens controlled vision, the profound hearing losses eliminating any possible contamination by audition, and the general communication handicap reduced the possibility of interaction pertaining to the experiment outside the classroom.

In most schools only two devices were available. Therefore, the experimental subjects were scheduled to receive programmed instruction at different times of the morning, some receiving this instruction while the teacher was presenting the controlled language instruction. Others in the experimental group were given seat work. Supervision of the experimental group by the teacher was minimal, being limited to that required to ensure that the child was working on the program independently.

It will be recalled that 20 daily programmed units had been prepared. The program was self-pacing in that the subject continued to be instructed through the program until the day's unit was completed.

Subjects of the experimental group who were absent, were, upon their return, given two sequential units daily until they had caught up with the remainder of the experimental group.

A maximum daily time limit was imposed upon the experimental subjects. This time was set at 45 minutes. However, since none of the total 1040 experimental subject-sittings required longer than the 45 minutes, it was not necessary to enforce this restriction.

3. Control group - Teachers were assigned a 45 minute period daily, a conventional instructional time-block, over 20 school days, in which to give formal language instruction. They were free to plan this 45 minute period for any time of the day convenient to them. It was suggested that afternoons be avoided because of possible fatigue of the control group. No restrictions were made as to the general method they employed except that they should familiarize the control group with the appropriate Fitzgerald symbols.

Teachers were requested to teach the language under investigation as they would normally do, putting no more, and no less preparation

into the lesson than usual. The investigators recognized the weakness of this control, but no additional controls were practicable, and it did have the advantage of simulating reasonably typical language instruction.

Teachers were instructed not to study the program but to prepare their lessons independently. They were permitted to order the content of instruction in any way they wished, and to teach intensively the language in which the control groups were weakest. They were also free to review as they wished within the 45 minute daily time limit.

The teacher's manual (Appendix A) described comprehensively the language to be taught, thereby assuring that the program content and teacher's instructional content would be held constant.

F. Language test

The language test was prepared by a teacher[1] solely from the Teacher's Manual and an accompanying test outline (Appendix A). The teacher was not shown the content of the program. A list of 50 sentences was prepared by the teacher, utilizing only the language listed in the Manual. The test outline guided the teacher in preparing these sentences, two sentences being prepared to test each of the 25 sentences outlined.

The 50 tentative sentences were submitted to the investigators. Five of the sentences were re-prepared to allow pictorial representation. One of each pair of sentences was randomly assigned to Form A, and one of each to Form B of the test, yielding two equivalent forms of 25 items each (Appendix B).

Fifty large poster illustrations were drawn by an artist to serve as pictorial stimuli for each sentence. The artist was instructed to avoid using the same illustrations as prepared for the program where by chance

[1] Miss Theresa Rolshouse, Teacher, Western Pennsylvania School for the Deaf

a sentence within the test was identical to a sentence within the program.

G. Collection of data

1. Tests of learning - The language test was administered by the investigators, assisted by the teacher of each class. The experimental and control groups took the test together. The investigators presented the illustrations one at a time. The teacher wrote the appropriate Fitzgerald symbols on the board. Subjects proceeded to write the 25 sentences tested by Form A and the 25 sentences tested by Form B with approximately an hour intervening. The test was administered as a power test, with no time restriction.

2. Daily record sheets - The thirteen participating teachers kept daily records of the time required by experimental subjects, absences in either group, teachers' observations, and a brief description of the content of their instruction that day (Appendix D).

3. Tests of retention - A group of 24 subjects was retested one month after taking the test originally. This group consisted of the experimental and control subjects of the four participating classes of a day school.

A test of retention was similarly administered to a second group of 19 subjects comprising two classes in a residential school. This test was administered two months after the original administration.

A third measure was gained from retesting a group of 12 subjects in another residential school, four months after the original test administration.

Teachers were not informed that their classes would be retested. There was therefore no control over practice in the interval between test and retest, and results were interpreted in light of this fact.

4. Original responses - The experimental subjects' original responses were retained and samples analyzed for (a) errors that were corrected by the subjects and (b) errors that remained uncorrected by the subjects.

5. Anecdotal information - At the conclusion of the experimental period in each school, the investigators met personally with each of the participating teachers and their supervisors. At this time, anecdotal information was collected and recorded.

H. Treatment of data

Data were in part processed through the use of an IBM 7070 computor[1]. Programs developed at the University of Pittsburgh Computation and Data Processing Center were used for this purpose[2].

1. Tests of learning- The total-score reliability of the language test was determined by the application of Rulon's formula (1939) to the composite scores (Appendix C) of forms A and B.

The experimental and control groups were tested for homogeneity of variance on composite scores and on each of six language variables, an F-ratio being computed on each.

The hypothesis of a common population mean was examined by means of the t test.

To test the hypothesis of a common population mean when homogenity of variance was rejected, an approximation of the t required for significance at the 1% and 5% levels of confidence was developed by reducing degrees of freedom by one-half (Edwards, 1950, p. 170).

The internal consistency of the program and of teacher-instruction was evaluated by intercorrelation matrices of the six language test

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[1] Under partial support of The National Science Foundation, Grant No. 11309.

[2] Correlation program by G. Lotto, and t-test program by A. Bendig (Write-ups on file in Computation and Data Processing Center, U. of Pittsburgh)

scores for the experimental and control groups. Fifteen correlation coefficients were derived for each sample and each coefficient transformed into z'. Z was obtained from each coefficient and a confidence level for the difference between the correlation coefficients for each of the fifteen pairs. (Edwards, p. 131).

2. Daily record sheets - The amount of time required by each experimental subject to complete each daily unit was taken from daily record sheets. The total time per subject for twenty days' programmed instruction was tabulated, the mean total time for the experimental group being derived from these data, and the standard deviation calculated.

The constant 45 minute control group time was compared to the mean of 19.3 minutes of the experimental group, and the significance of the difference ascertained. It should be noted that the control group time was fixed, and therefore had no variance. Transformation to z score was utilized.

3. Tests of retention - Three sets of data were collected, one for a sample retested after the one month interval, one for a sample retested after the two month interval, and one for a sample retested after the four month interval.

Composite scores were used (Appendix C). Original test and the retest were each scored in this way so that each subject being retested had two composite scores.

Each of the three sets of data was treated separately. Because of the reduction of the sample due to absences at the time of testing, the sample tested for retention after a four month interval could not be tested for significance. Data from groups tested for retention after two and ~~four~~ one month intervals were tested for significance of difference in reten-

tion by means of a standard repeated measurements t-test (Edwards, p. 285).

4. Original responses - The raw responses of experimental subjects were examined for correctness and errors, the latter being checked for corrections made by the subjects and those which remained uncorrected. A sample of ten percent of the experimental group was considered adequate for this purpose. Accordingly, the responses of six subjects were randomly selected for such an analysis. The mean composite score of the 52 experimental subjects was 78.06, and for the sample of six, 78.66. The mean age of the sample was nine years, ten months. The sample was therefore taken to be representative.

Responses made by the six subjects on the first eight program units were examined, giving a total of 1314 frames. Correct responses, corrected errors, and uncorrected errors were tabulated and reported as percentages of total responses.

Most frames required full sentence responses so that in effect each frame required several responses dependent upon the number of words in the sentence. The entire sentence was treated as a single response since only an errorless sentence had received positive reinforcement.

5. Anecdotal information - Observations made by teachers were reported when the same observation was made by two or more teachers. Observations were of a subjective nature, and this fact should be kept in mind in their interpretation.

Some observations were negative, and some positive. Due to the shortness of the program, transfer to original language could only be inferred from teachers' observations.

V. Results

A. Effects on language acquisition

1. Differences between means - The mean composite scores of the experimental group and the contrd group respectively were 78.06 and 85.28. The standard deviation for the experimental group was 31.59 and for the control group, 41.47. With a resultant F-ratio of 1.73, homogeneity of variance was accepted at the 5% level. With t=.97, the null hypothesis of no significance of difference between the means was accepted at the 5% level.

Table 2. Breakdown of Language Test on Six Variables

Score	Experimental Group[a] Mean	S.D.	Control Group[b] Mean	S.D.	t	F[c]
1. Nouns	36.02	14.36	35.40	12.58	.22	1.30
2. Verbs	11.79	6.30	13.94	7.18	1.57	1.30
3. Predicate Adj.	5.13	2.89	6.91	3.86	1.59*	1.79*
4. Comp. Adj.	3.27	2.23	3.00	2.22	.60	1.00
5. Pred. Nom.	4.44	2.35	4.15	3.18	.52	1.84*
6. Full Sentence	18.29	11.23	21.83	15.57	1.29	1.92*

(a) Experimental group n=52
(b) Control group n=49
(c) Two-tailed test (Critical value of F=1.772 with tabled value p.=.025)
* Significant at 5% level of confidence

F-ratios in Table 2 are seen to be significant at the 5% level of confidence on three of the six language variables, indicating greater variability within the control group than within the experimental group on predicate adjectives, predicate nominatives and full sentences. Homogeneity of variance was accepted at the 5% level of confidence on nouns,

verbs, and comparative adjectives.

No significant differences were revealed by t tests at the 5% level of confidence between the mean of the experimental group and the mean of the control group on five of the six language variables (nouns, verbs, comparative adjectives, predicate nominatives, full sentences).

The null hypothesis was rejected for predicate adjectives at the 5% level of confidence.

2. Consistency of instruction

Table 3. Intercorrelation matrix of language scores-experimental group

Variables	2	3	4	5	6
1. Nouns	.527**	.227	.562**	.681**	.750**
2. Verbs		.296*	.541**	.543**	.807**
3. Pred. adj.			.350*	.334*	.487**
4. Comp. adj.				.499**	.736**
5. Pred. nom.					.736**
6. Full sentence					

n=52
* Significant at 5% level of confidence
** Significant at 1% level of confidence
A 2-Tailed test was used to determine confidence levels in Tables 3, 4, and 5.

Table 4. Intercorrelation matrix of language scores-control group**

Variables	2	3	4	5	6
1. Nouns	.839	.676	.806	.690	.855
2. Verbs		.716	.811	.722	.914
3. Pred. adj.			.732	.691	.830
4. Comp. adj.				.674	.893
5. Pred. nom.					.831
6. Full sentence					

n=47
** All intercorrelations in matrix were found significant at 1% level of confidence.

Table 5. Differences between correlation coefficients of experimental and control groups expressed as z

Variables	2	3	4	5	6
1. Nouns	2.99**	2.84**	2.31*	.09	1.45
2. Verbs		2.85**	2.51**	1.46	2.00*
3. Pred. adj.			2.71**	2.43**	3.16**
4. Comp. adj.				1.29	2.32*
5. Pred. nom.					1.19
6. Full sentence					

* Significant at 5% level of confidence
** Significant at 1% level of confidence

Tables 3 and 4 give the incorrelation matrices for the six language variables of the experimental and control group respectively. Comparison of the 15 pairs of correlation coefficients shows higher coefficients obtained by the control group on all 15 pairs.

These 15 differences were tested for significance. As indicated by Table 5, seven of these differences were found to be significantly different from each other at the 1% level of confidence and three at the 5% level of confidence.

From observations of the results of these statistical tests, there is every indication that the internal consistency of the programmed instruction was considerably lower than that of teacher-instruction.

B. Efficiency of time

Table 6. Amount of time of instruction in minutes

Group	Total time per subject	S.D.	Daily Time (20 days)
Experimental	386.5 (mean)	120.5	19.3
Control	900 (constant)		45 (constant)

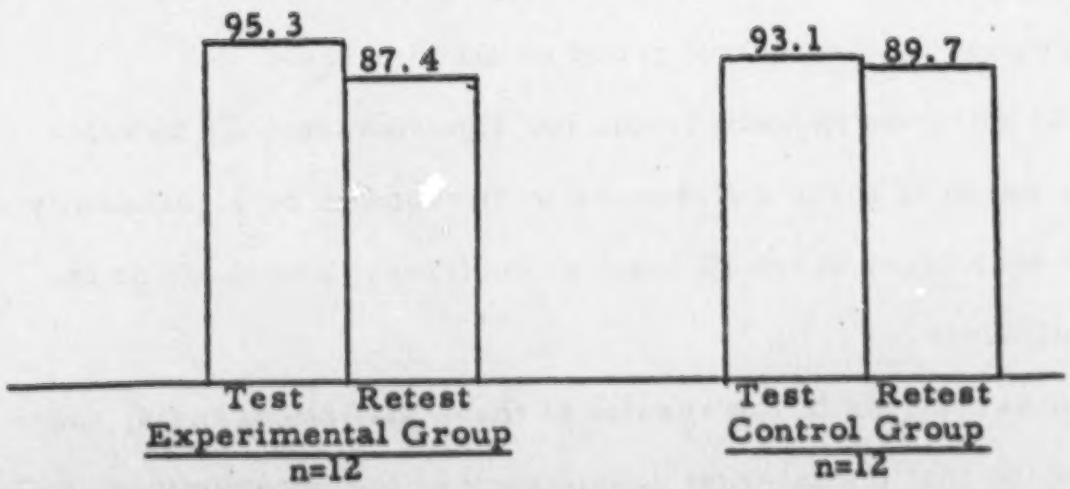
$z = 4.26$
$P < .0001$

Time was held constant for the control group at 45 minutes per day, or a total of fifteen hours instruction. The experimental group daily mean per subject time was 19.3 minutes, totalling approximately 6-1/2 hours instruction.

The total time of 900 minutes was transformed into a z score of 4.26. The significance of the difference in time given the two instructional procedures was established at the 1% level of confidence.

C. Retention

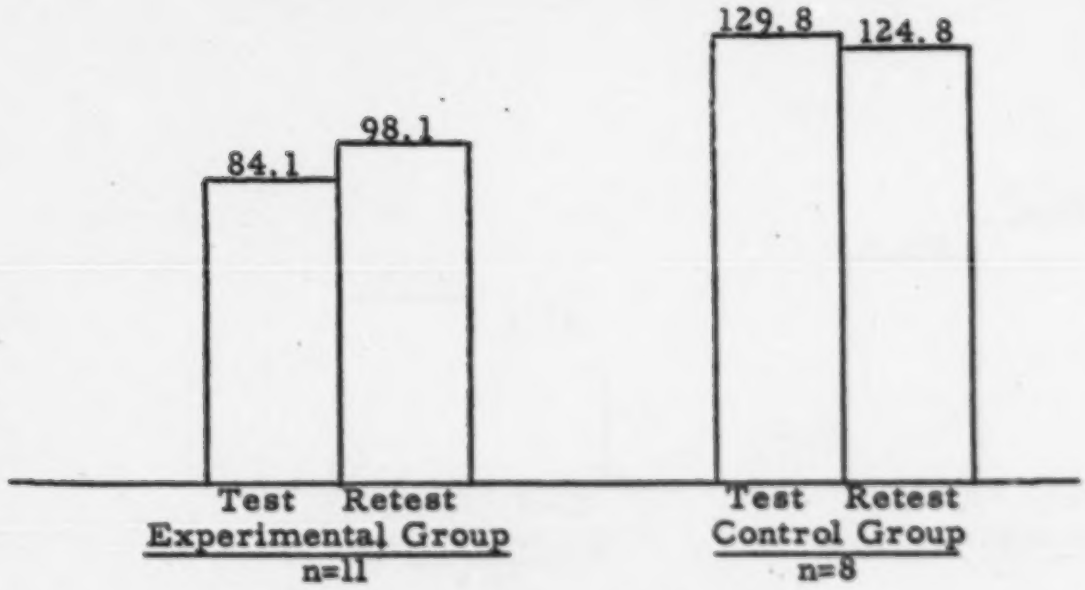
Graph 1. Test and retest scores after one month interval



Twelve experimental subjects retested after a one-month interval dropped in mean score by 7.9 points, while twelve control subjects dropped in mean score by 3.4 points. The difference was not found to be significant (t=.332).

While the null hypothesis is accepted for this group, this sample was not randomly selected from the total sample of 97 subjects. The question of retention therefore, needs further investigation.

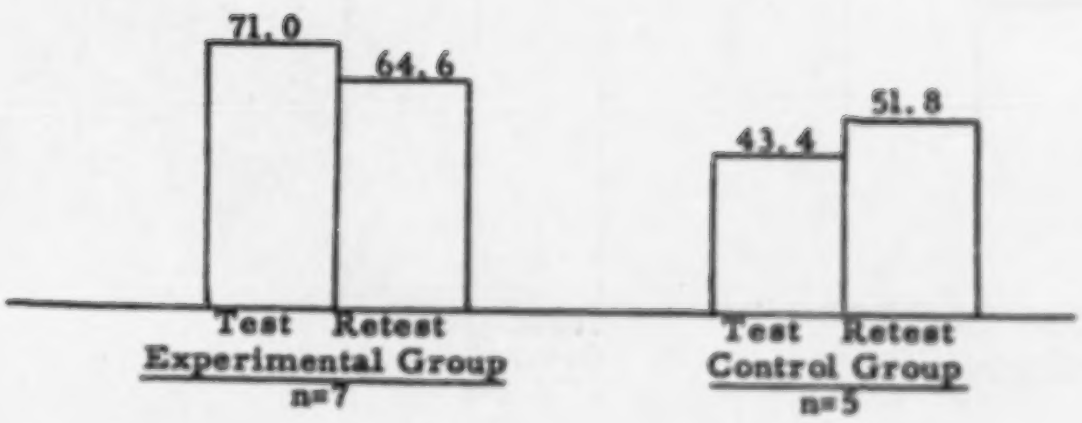
Graph 2. Test and retest scores after two month interval



A second sample was selected for retesting after a two month interval. Eleven experimental subjects showed a mean gain of 14.0 points on the retest. Eight control subjects dropped in mean score by 5.0 points. No significant difference was found between the mean of the difference between test and retest for the experimental group and the corresponding mean of the control group (t=.663).

Gains on the part of the experimental group clearly indicate that the retest scores do not represent retention but an intervening variable operating between the two test administrations, presumably added instruction on the part of the teachers.

Graph 3. Test and retest scores after four month interval



After both two and four month intervals, the group with the lower initial test scores showed gains, the group with the higher initial test scores showing losses on retesting.

D. Correction of responses

Table 7. Analysis of responses

	No. of frames	Percentage of total responses
Correct responses	1201	91.4
Corrected errors	57	4.3
Uncorrected errors	56	4.3
Total Responses	1314	

A 5% error frequency has been suggested as a ceiling for optimum reinforcement. If this figure is accepted, then the figure of 8.6% (corrected and uncorrected errors) seems high.

Several subjects were noticed manipulating the self-instructional device to read the correct answers before writing their responses. These subjects were in effect utilizing prompts intended by the investi-

gators to be confirmations. The true error frequency, therefore, probably exceeded the recorded 8.6%.

E. Teachers' observations

The expressed reaction of twelve participating teachers following the experiment was one of enthusiasm, some qualified, some unqualified. One teacher was restrained in her comments.

Negative comments made by more than one teacher were:

1. The self-instructional devices jammed frequently, breaking into the learning activity of subjects working with them. Some subjects were able to readjust the rolls without the teacher's assistance. Some subjects checked the correct answers before writing their responses.
2. Too much language material had been assigned for adequate instruction in one month.
3. The program should have employed more different picture-stimuli in order to facilitate generalization.

Positive comments made by more than one teacher were:

1. An improvement was noticed in the general sentence structuring of the subject's original language, i.e., "I have a student who uses the subject, verb and object better." Another supporting statement was made to the effect that the program had apparently made the children more aware of the correct ordering of words in a sentence.
2. Vocabulary learned through programmed instruction appeared frequently in the written original language of the subjects.
3. Interest of the experimental subjects was sustained throughout the one month experimental period. Two teachers independently stated that experimental subjects of low mental ability appeared to particularly enjoy the instruction.

Teachers made conflicting comments in relation to transfer. Transfer from programmed instruction of verbs to original language was noticed by most teachers. Some felt that these verbs were being used appropriately, particularly the agreement of verb endings with subject. However, two teachers noticed the present progressive tense being used very frequently in original language, to the exclusion of more appropriate tenses. Also, the verb 'be' was more frequently used, and some subjects were not correctly discriminating when 'be' should be used and when 'have' should be used.

The implicit reaction of teachers to programmed instruction was suggested by the fact that several teachers stated their intention of programming additional instruction for students in their classes. A committee was formed in one school for such a purpose. In another school, teachers retained the programs after the conclusion of the experiment not for the purpose of further experimentation, but as clinical aids.

VI. Conclusions

A. The questions under study

The questions posed earlier (II. The Problem) now can be answered, in large part.

1. As to the relative effects of programmed instruction and conventional teacher-instruction on the acquisition of written language, no differences of any appreciable magnitude can be discerned. Children seem able to learn essentially the same content under either approach.

2. Regarding efficiency as measured by time taken to accomplish the same amount of learning, the programmed instruction is far more efficient than conventional teaching. The very substantial saving in time is shown by the general finding that children using programs learned the same amount as children receiving conventional teaching in less than half the time.

3. The young children who participated in this study demonstrated sufficient perceptual skills to match full sentence responses with correct answers.

4. Taken as a whole, the response of teachers of the deaf to programmed instruction in their classrooms was favorable. Generally, the teachers expressed a desire to have more programs of a similar kind for regular use.

B. Discussion

In the evaluation of programmed instruction, two criteria predominate, amount of learning, and speed of learning. General learning efficiency is a function of both.

A comparison of the composite scores of the experimental and control groups revealed no significant difference between mean scores.

On the first criterion, in a breakdown, it was seen that on five of six language variables, there was no significant difference in language acquisition by deaf children receiving programmed instruction and by deaf children receiving teacher-instruction. On a sixth language variable, predicate adjectives, the teacher-directed instruction resulted in significantly higher performance.

Differences in the consistency of performance by subjects on the six variables by the two procedures of instruction were tested. Teacher-instruction resulted in generally higher consistency of performance than did programmed instruction. This may have been due to the linearity of the program, or to the better adaptation of the teacher to specific language weaknesses on the part of individuals in the class. The internal consistency of most programs is not tested through use of intercorrelations and the results of this analysis may be consistent with other linear programs.

On the second criterion of rate of learning, it was seen that the children receiving programmed instruction required less than half the time of instruction to arrive at learning generally equal to children receiving conventional teacher-instruction. The effect of a program doubled in length can only be inferred. However, it would almost certainly increase learning and subsequent performance. Perhaps the arbitrarily established amount of time assigned to teachers was unnecessarily high. This is unlikely judging by comments from some teachers to the effect that too much

language had been assigned for one month's instruction.

Comparison of test and retest at one, two, and four month intervals was intended to provide a test of retention. While results showed no statistical significance of difference in retention between the two procedures, some groups improved in performance on retesting. The retest therefore cannot be said to measure retention. Obviously lack of the investigator's control over the interval between test and retest influenced the results. Observed gains of the lower initial-scoring group toward a higher retest score suggests that teachers followed the experiment with increased instruction, particularly of this group.

This gain raises the interesting hypothesis that teachers tend to direct their instruction toward improving the performance of students with a low initial level of performance, and that in so doing, sacrifice improvement or even the maintenance of initial high performance of better students.

The relative effect of the two procedures upon retention remains unknown.

The percentage of total responses found to be in error was 8.6%. This percentage must be interpreted in terms of the fact that a written sentence in fact contains several responses. A single response error causes the full sentence or group of responses to be in error. This percentage is therefore considered satisfactorily low. That one-half of these errors remained uncorrected is of greater concern in terms of possible conditioning of errors.

Teachers' reactions to programmed language instruction were generally highly favorable. Their observations raise several researchable questions.

C. Implications

The results of this investigation, while they leave several questions unanswered or partially answered, give strong support to the feasibility of programming written language for young deaf children.

In the development of a comprehensive written language program for deaf children, consideration should be given to:

1. Careful ordering of language elements to be incorporated into the program. There is some risk that a highly structured language program will condition children into overly generalized responses unless a particular sentence is quickly followed by another directed at discrimination - i. e., children should be taught 'be' and 'have' in close sequence.

2. Incorporation of a branching technique. To assure relatively high consistency in the acquisition of various language elements, opportunity for increased instruction in different elements should be available to the child. Experimentation should accompany program development to detect program inadequacies.

3. Strengthening the program with the use of a wide variety of picture-stimuli.

4. Means of reinforcing specific parts of speech within a full sentence response. An adaptation of a self-instructional device could

be made to allow matching of specific parts of speech within a sentence before the compete sentence was matched.

This investigation in turn raises other questions to be answered by research:

1. What is the amount and quality of transfer from programmed instruction into original written language and into oral language?

2. What is the effect of the systematic interaction of program and teacher on language? i. e., should certain language variables such as the predicate adjectives be taught directly by the teacher? What learning would result from 20 minutes programmed instruction followed by 25 minutes of teacher-instruction?

3. Does increased written language acquisition produce concomitant increased reading skills? If so, can a single program be developed to direct itself deliberately toward the establishment of both skills?

VII. Summary

The feasibility of programming written language for the instruction of deaf children was investigated.

A program was developed and given a group of deaf children. A control group was taught the same language by teachers.

While the internal consistency of teacher-instruction was higher than that of programmed instruction, no significant difference was found between the mean scores on five of six language variables. The control group scored significantly higher on one variable. The programmed instruction required less than one-half the time assigned to teacher-instruction.

Written responses were correct on over 90% of the frames. Less than 5% of the total responses showed uncorrected errors.

Participating teachers reacted generally enthusiastically to this method of written language instruction.

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Appendix A
Teacher's Manual with Sentence Outline

Introduction

You have been invited to participate in a project designed to yield information on the acquisition of written language by deaf children. As teachers of the deaf we agree that this area requires a great deal more exploration. You, in your involvement in this investigation, will be offering a considerable professional service to this end. In the succeeding paragraphs we describe in detail your role in the project. As in all investigations of this sort, there must be experimental controls. For this reason we carefully spell out the procedure. Since you are one of a number of the teachers in the several schools participating, there is a need for a standard approach. The validity of the investigation is contingent on your adherence to this standard. However, we wish also to capitalize on your creative resources as a teacher of the deaf in the instruction of your children.

Background of Programmed Instruction

Perhaps you have read something of programmed instruction within the past year or two. You may be familiar with self-instructional devices or teaching machines. The influence of the discipline of psychology in education has been mainly in the testing area. However, there has been for many years a core of psychologists interested in the basic problems of learning. Out of their research has come a group of learning principles which have been packaged for instructional purposes. We have called this package programmed learning.

Programmed learning is learning through participation. The responsibility for learning is placed largely upon the learner. Programmed instruction is an individualized, tutor-like approach. The student is tested following each instructional item. He must respond to each item. Further, he is unable to proceed to new learning until, by his response, he has indicated to himself that he has mastered the preceding item. Each student, because his instruction is individualized, moves at his own rate. These qualities, together with the programs which follow sound psychological principles, suggest that programmed instruction may lend itself to educational application.

The task of programming involves the preparation of a series of steps designed to carry the student to the learning objective. Each step is called a frame. A full year's instruction in a specific subject area might involve several thousand such frames. Several media are employed to transmit programmed learning. This study utilizes a self-instructional device or teaching machine. Some programs have been written in the form of textbooks. These textbooks are quite unlike those we know, however.

Many programs have been prepared, some excellent, some poor. They deal with mathematics, foreign languages, science and many other

subject areas. Indications are that a well-prepared program leads to accelerated learning. Poorly-prepared programs may be expected to have the reverse effect.

Another Gadget?

Teachers frequently resist the notion of automation in the classroom. They state that no mechanical device can replace the interaction between teacher and student. On this latter point, they are quite correct. No program can provide the enrichment a student needs for fulfilment. Neither can a group hearing aid produce speech skills by itself. A rationale for programming is that the teacher is relieved of much of the drill presentation and can give herself to the child's enrichment with time to devote to the needs of specific students.

In teaching speech, for instance, we often assume a tutor's role, working with a particular child while the others occupy themselves with seat work. Programmed learning is seat work designed to give the child the drill he requires while at the same time providing full opportunity for learning to move forward in a systematic way. The teacher's effectiveness is increased and the program becomes a teacher's aide.

Many devices have been marketed for instruction of deaf children. Some of these now collect dust in your storeroom because their usefulness is limited. Is programming another gadget? We do not think so. As a teacher, we hope very much that you will help us determine the efficacy of programmed self-instruction.

Why Select Language?

The language arts are the core of instruction for deaf children. Written language was selected as the subject area for several reasons. We do not yet know how to teach oral language and speech through a programming technique. Written language, however, has been highly refined and systematized for instruction to deaf children. Programming would appear to lend itself to this systematic manner of presentation. Because you are familiar with the Fitzgerald Key, and because key symbols are used in the program, your teaching can parallel that of the program. We can, therefore, evaluate the technique rather than the system.

Why Select You?

You have been invited to participate in this investigation because your class meets several specific criteria which we shall discuss subsequently.

We by no means wish to evaluate you as a teacher. This is neither our province nor our concern. It is assumed that you meet the high standards typical of teachers of the deaf. The data which your class provides will be massed with that of ninety other children.

Your class will be split in two. You will teach one-half of the class in the usual way. You will teach the other members of the class by means of the self-instruction programs we provide. It is not necessary

that your class be divided into equally able groups because this possibility is allowed for through our use of a large sample of children.

Procedure

This study will run throughout four weeks or twenty school days, with a test scheduled to follow.

One-half of your class will be selected as the control group. This is the group which you will teach specific language. The other half of your class will be the experimental group, receiving programmed instruction. These two groups will be divided only for the language period.

You are asked to set aside a quiet corner of your classroom. The device can be set on a low desk or table, facing the wall. Since there will be but one device, the experimental group will take turns working there throughout the morning. You can schedule your language period for the regular time. One of the experimental group might be working on the program at that time. It is most important that the remaining members of the experimental group not observe your language period, so you are asked to turn their desks around and to give them seat work at that time. Schedule these children to work on the program at different times. Since you may be forced to schedule their programmed instruction while you are teaching another subject, they will lose some of that instruction. It is suggested, then, that you adjust their schedule so that different children work on the program at a specific time from day to day. Ideally, there would be a program for each of the children taking this instruction. This is not possible just now.

The program has been divided carefully into twenty sections, each of approximately the same length. The child will work on each segment until he completes it. Should the child's work be stopped by recess or another interruption, then he should complete it upon the class' return. It is to be hoped that your scheduling would avoid this where possible.

One of the aspects of programmed learning which we wish to explore is its effect upon the child who has been absent. Accordingly, if a child has been absent, then he should be scheduled extra periods on the program in order to make up what he has lost through his absence. He should be given two programs per day until he has caught up. Please keep a record of absenteeism.

It goes without saying that just as members of the experimental group should not be permitted to observe your instruction, children of the control group should not use the program.

Language instruction naturally continues throughout the day, whether it be calendar work, news, reading or letters. Your entire class, with the exception of any child who might be working on the program at that time, would participate. We are concerned only with that particular period which is set aside for formal language instruction. You are asked only to avoid using that language material and vocabulary which is set aside for formal instruction by you and by the program at any time of the day other than during that specific period. It is recognized that you cannot adhere strictly to this restriction, but you are asked to refrain from

additional direct instruction where possible.

Assumptions

Your class will have had several years of formal language instruction by this time. However, in recognition of varying ability levels among the children and methods of instruction, a minimum of assumptions have been made.

In order to guarantee that both the control group and the experimental group have attained a common core of knowledge, you are requested to spend as much time as you deem necessary before the four week experiment begins to teach or review the following assumptions. The entire class should receive this instruction.

1. that all the class understand the concepts and terms "present, past and future." Note that "present progressive" should be taught the control group during the four week experiment.

2. that the students know that most nouns are pluralized simply by adding "s" and compounded by "and".

3. that the class recognize "Who, What" and the verb symbol as found in the Fitzgerald Key. Note that the symbol for the predicate adjective and predicate nominative should be taught during the experiment.

Undoubtedly many in your class are already familiar with much of the vocabulary and the language principles taught in this experiment. However, you are asked to teach or review such material anyway in order to guarantee a high score on the test.

Content of Instruction

On the basis of consultation with experts in language instruction to the deaf together with an examination of courses of study of representative schools, the following three areas have been selected for special instruction, together with a specific vocabulary list.

1. seven verbs, in the third person, singular and plural, with past, present and future tenses; also the present progressive tense, except in the case of the verb "be". Stress is placed on the agreement of verb with singular and plural nouns as simple and compound subjects.

2. predicate nominatives (preceded by the verb "be").

3. predicate adjectives (preceded by the verb "be") and comparative adjectives.

Your Method of Instruction

Your entire class will be given a single test at the conclusion of the four week experimental period. Care must therefore be taken to avoid creating an unfair bias favoring either group. Consequently, certain criteria should be adhered to.

Fitzgerald Key symbols will be used to draw language from the students in the test. The experimental group will be instructed with the utilization of the necessary key symbols. You are asked to do likewise so that the control group will be at no disadvantage during the test.

Since the test has been developed to measure learning, you are justified and indeed urged to teach for the purpose of preparing the control group for the test. So please use it as a guide to direct your instruction. This includes the teaching of vocabulary.

Time your formal language instruction over the four week experimental period and limit these periods to 45 minutes a day. You are asked to avoid using the vocabulary or principles contained in the experiment outside this period except as they should arise incidentally.

With these provisions, you are free to organize the language as you wish. You may teach the four units and vocabulary as you think best to assist your instruction. Remember, however, that the vocabulary used in the test will be drawn from the vocabulary list in the test section. Introduce review as you wish within the twenty formal language periods.

Your only assistance to the children of the experimental group should be in setting up and supervising the operation of their program. You will necessarily see some of the program in setting it up before each sitting. Please refrain from imitating the procedure you see there except as it is similar to your own method by coincidence.

It is not expected, in view of the extensive amount of material to be covered, that either of the two groups will master all the content. So please do not be overly concerned if you do not have the time to cover all material adequately.

Test Preparation

The test will be prepared by an experienced teacher of young deaf children. In order to eliminate bias favoring either group, this teacher will not have seen the programmed material but will use the information under "Test" to prepare her test.

Test

Children will be tested only on that vocabulary which appears in the following lists. This description classifies vocabulary as it may be expected to appear on the test.

Pictures will be shown the children. They will be tested on their ability to use full sentences to express what each picture shows.

In order to direct their sentences and to provide them with assistance, pictures will be presented with the Fitzgerald Key symbols.

- i.e.,

Picture of boy jumping

Who: ═══

Past

_____ _____

The students will be expected to know in most instances, the correct verbs to be used - i.e., that the verb 'be' precedes the predicate adjective and predicate nominative.

Students will be expected to recognize these symbols -

Who, What, ═══, ┌──┐, ═══,
Comparative adjectives will be represented by the predicate adjective symbol, and predicate nominatives by their appropriate symbol.

The test may involve the use of all the vocabulary list in the appendix so you are advised to teach all of this vocabulary within your language period.

Students will be tested on their ability to write the following vocabulary in sentences.

(1) Verbs

was (were) - is (are) - will be
played - play(s) - will play - is (are) playing
walked - walk(s) - will walk - is (are) walking
ran - run(s) - will run - is (are) running
jumped - jump(s) - will jump - is (are) jumping
swam - swim(s) - will swim - is (are) swimming
threw - throw(s) - will throw - is (are) throwing

(2) Nouns

Students will be expected to write only those plural forms which are made simply by adding "s". No preceding article will be expected of plurals. Singular nouns should be preceded by the article "a" or "an" except where the absence is indicated in the list.

These nouns may be used either as subjects or following "than".

a peacock	a dog	the weather
a lion	a house	an elephant
an owl	a church	a rope
a deer	a store	a rocket
a girl	a barn	a thread
a boy	a school	a horse
a sailor	a doll	a baby
a doctor	a kite	___ milk
a fireman	a ball	___ ice

(3) These nouns will be used as predicate nominatives only, under the symbol _____.

a man
an animal
a building
a toy

(4) This list will be used as predicate adjectives only, under the symbol ⌐_____¬ .

strong
big
cold (pertaining to body temperature)

(5) Students will be tested on the following comparative adjectives, under the predicate adjective symbol ⌐_____¬ .

stronger than _____
bigger than _____
colder than _____

Where a direct object is required - i.e., following transitive verb "throw", the students will be given the direct object.

-i.e.,

	Who	═══	What
Picture of girl throwing a ball.	_____	Present Progressive _____	a ball

If a word is not employed in the vocabulary list the student will be given that word

- i.e.,

	What	═══ Past	fly
Picture of owl flying.	_____		flew

The test will require students to construct 25 sentences, appropriate key headings and tenses being given.

Who / What		
1. singular	past	
2. plural	past	
3. singular	present	
4. singular	present	
5. plural	present	
6. plural	present	
7. singular	future	
8. singular	future	
9. singular	present progressive	
10. plural	present progressive	
11. singular	present progressive	
12. plural	present progressive	
13. singular	past	predicate adjective
14. plural	past	predicate adjective
15. singular	present	predicate adjective
16. plural	present	predicate adjective
17. singular	future	predicate adjective
18. singular	future	predicate adjective
19. singular	present	comparative adjective
20. singular	present	comparative adjective
21. singular	present	comparative adjective
22. singular	present	predicate nominative
23. singular	present	predicate nominative
24. singular	present	predicate nominative
25. singular	present	predicate nominative

Appendix B
Answers of Language Test

Form A

1 A deer ran.

2 Boys played.

3 A horse walks.

4 A girl swims.

5 Dogs run.

6 Girls play.

7 A horse will jump.

8 A lion will jump.

9 A girl is jumping.

10 Firemen are running.

11 A boy is throwing (a ball).

12 Boys are swimming.

13 A dog was cold.

14 Girls were cold.

15 The weather is cold.

16 Lions are strong.

17 A rocket will be big.

18 A school will be big.

19 A peacock is bigger than an owl.

20 Mr. Green is colder than Mr. Brown.

21 A boy is stronger than a baby.

22 A sailor is a man.

23 A store is a building.

24 A horse is an animal.

25 A ball is a toy.

Form B

1 A dog ran.

2 Horses jumped.

3 A dog walks.

4 A boy swims.

5 Deer run.

6 Lions walk.

7 A boy will play.

8 A baby will walk.

9 An elephant is walking.

10 Sailors are running.

11 A baby is playing.

12 Horses are running.

13 A kite was big.

14 Firemen were strong.

15 An elephant is big.

16 Elephants are big.

17 A boy will be strong.

18 A church will be big.

19 An elephant is bigger than an owl.

20 Ice is colder than milk.

21 A rope is stronger than a thread.

22 A doctor is a man.

23 A barn is a building.

24 A deer is an animal.

25 A doll is a toy.

Appendix C
Scoring of Language Test

Six independent scores were derived from the total test (Form A and Form B). A seventh composite score was derived from these six.

1. Nouns. The subject of each of the fifty sentences was examined. To be correct, the article must agree with the noun. Infrequently, nouns not intended by the investigators but equally acceptable, were used. i. e., 'pony' for 'horse'. These were considered correct.

possible score, 50

2. Verbs. The first twelve sentences of each of the two forms were examined for correct verb, tense and agreement. possible score, 24

3. Predicate Adjectives. Sentences 13 through 18 were scored for correct predicate adjectives. possible score, 12

4. Comparative adjectives. Sentences 19 through 21 provided a score for comprative adjectives. To be correct, the subordinating conjunction 'than' must follow the adjective and the two nominative cases be in correct sequence. possible score, 6

5. Predicate nominatives. Sentences 22 through 25 were scored for predicate nominatives. possible score, 8

6. Full Sentence. All the sentences were examined for their total correctness (syntax and vocabulary). To be considered correct, the complete sentence must be errorless. possible score, 50

7. Composite score. This single score was derived as the sum of scores 1 through 6. possible score, 150

Appendix D

DAILY RECORD SHEET

Day (1-20)_____

Experimental Group

Name	Minutes taken
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Notes about children's performance, machine functioning, children absent, children catching up for former absence, etc.

_____

_____

_____

_____

_____

_____

Control Group

What you taught during the language lesson (also absentees).

_____

_____

_____

_____

_____

Apperdix E
Technique of Teaching Predicate Nominatives

The following frames are selected to demonstrate the method of establishing the predicate nominative. A total of 82 frames is given to this instruction.

Sample Frame 1.

	(correct answer) buildings (revealed after response is made) 2.
	(cues) What: (Subject copies underlined word) buildings 1.

Succeeding frames establish spelling of "buildings" by fading syllables, and proceed to teach "house, church, school, and barn", ie.,

Sample Frame 2.

	a barn 2.
	What: a barn 1.

Sample Frame 3.

a barn

2.

What:

a ----

1.

Vocabulary having been established, it must now be structured. The verb "be" has been taught in an earlier unit.

Sample Frame 4.

A barn is a building.

2.

What:	Present	
A barn	is	a building.

1.

Sample Frame 5.

A barn is a building.

2.

What:	Present	
A ----	--	a--------.

1.

A terminal frame is:

Sample Frame 6.

A barn is a building.

2.

What: ___ **Present** _____

_____ ____ _____

1.

The nouns "church, store, house" having been similarly taught, a change in the picture stimulus produces:

Sample Frame 7.

A house is a building.

2.

What: ___ **Present** _____

_____ ____ _____

1.

A terminal frame using another predicate nominative is:

Sample Frame 8.

A lion is an animal.

2.

What: **Present** _____ _____ ____ _____

1.

But notice that a picture might remain constant while the symbolic cues change. The total stimulus (picture plus symbolic cues) changes to produce:

Sample Frame 9.

A lion is jumping.

2.

What: **Present Progressive**

_____ _____

1.